

UAF Light Detection and Ranging (LiDAR) and Ortho-Imagery Data Project Report Bradfield to Behms Corridor

Tetra Tech was contracted by the University of Alaska Fairbanks (UAF) to provide LiDAR and ortho-imagery data for the Road to Resources in Alaska Program. Tetra Tech collected LIDAR data and aerial imagery during the fall of 2013 and the spring/summer of 2014. Included within this document are the various reports required by the contract.

Collection Report

LiDAR data for the Bradfield to Behms corridor project area was acquired with a Cessna 401 aircraft. The tail number of this aircraft is N34MM.

LiDAR Sensor:

Optech Orion H300

Imagery for the Revilla corridor project area was acquired with a Piper Aztec PA-23-250 Turbo twin aircraft. The tail number of this aircraft is C-FKSK.

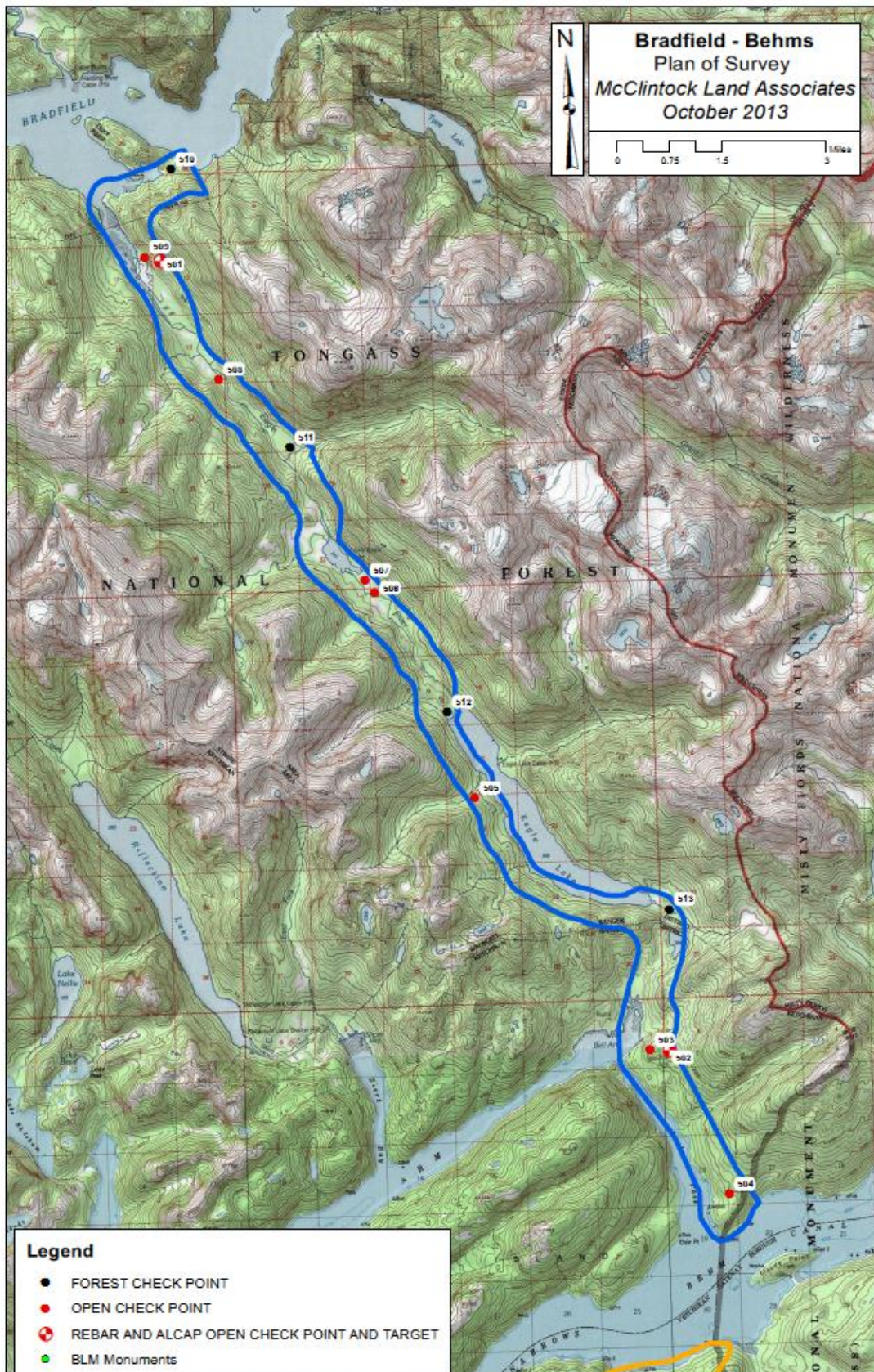
Imagery Camera:

Microsoft/Vexcel UltraCam Eagle Digital Mapping Camera

Survey Report

Each polygon area contains calibration points as well as independent check points. Check points have been withheld from Tetra Tech. The coordinates with field notes for each area will be provided to GINA directly by the surveyor, McClintock Land Associates.

The Bradfield to Behms area contains 3 calibration points and 9 independent check points as shown in the diagram below.





Certification from Surveyor

Bradfield-Behms

QUALITY CONTROL REVIEW SUMMARY

Max. High Elev. Deviation: 0.51 feet
 Max. Low Elev. Deviation: -0.48 feet
 Elevation Deviation Range: 0.99 feet
 Elevation Deviation Mean: 0.04 feet
Elevation Deviation RMSE 0.31 feet

(RMSE = Root Mean Square Error)

CHECK POINTS			SURVEYED Elevation (Feet)	CATEGORY	TIN File Name	LiDAR Elevation (Feet)	Deviation (Feet)
Point Number	Northing (Feet)	Easting (Feet)					
503	1528501.01	3145635.94	252.57	Open	L31450_15275	252.31	-0.26
504	1517498.20	3152540.36	336.56	Open	L31525_15150	336.88	0.32
505	1548032.49	3133457.33	513.20	Open	L31325_15475	513.18	-0.02
506	1562174.39	3125805.58	311.72	Open	L31250_15600	311.83	0.12
508	1579639.38	3113430.34	57.79	Open	L31125_15775	57.50	-0.29
509	1588783.36	3107794.17	15.60	Open	L31075_15875	15.77	0.17
510	1593389.87	3107098.03	39.78	Forest	L31050_15925	39.30	-0.48
511	1574470.94	3119242.59	153.74	Forest	L31175_15725	154.25	0.51
512	1554343.43	3131037.23	312.49	Forest	L31300_15525	312.87	0.38

TIN CERTIFICATION

Date Prepared: 1/14/2015

Roads to Resources – BRADFIELD TO BEHMS TIN Surface Model

Prepared by: McClintock Land Associates, Inc.
Prepared for: Tetra Tech, Inc.

I hereby certify that an independent ground survey was performed under my supervision to obtain sampling data to be used to test the reliability of the electronic Triangular Irregular Network (TIN) surface model for Bradfield to Behms, Alaska. This TIN is based on the Model Key Points Method. For ease of manipulation the surface model was divided into 106 cells as defined by the .dwg files shown on the attached listing.

These files were produced by Tetra Tech, Inc. from a LiDAR survey. The LiDAR data was acquired and calibrated by Aerial Surveys International flown on June 26 and July 11, 2014 and processed by Tetra Tech, Inc. between October 29, 2014 and January 9, 2015.

The independent ground survey was performed by McClintock Land Associates, Inc. October 18 - 19, 2013 and May 1, 2014 using Static and RTK GPS methods as well as conventional optical methods. Topcon Data Collectors, along with Topcon HiPer GA and GR-3 GNSS receivers were used as well as a Topcon GPT-3005LW Reflectorless Electronic Total Station. Topcon Magnet Field v2.0.1 data collection software was used for the field data collection and Topcon Magnet Office Tools v2.0.1 office software was used for post-processing and adjustments.

The survey data was collected in Alaska State Plane Coordinates, Zone 1 (NAD83) in US Survey Feet. The vertical datum is NAVD88 in feet and elevations were determined as approximate orthometric heights using Geoid Model 2012A. Ties to the NSRS were made using the NGS OPUS Utility. A more detailed description of the methods and control will be contained in the Survey Report for this project.

This TIN was checked using independent QC check points which had been withheld from the TIN producer. The RMS error standard for ASPRS Class 2 Maps for Vertical Accuracy for a 2 foot contour interval map is $\frac{2}{3}$ of the contour interval or 1.33 feet. The RMS error between the elevations returned from the TIN and the actual check points was 0.31 feet. This map meets and exceeds that standard.



William McClintock

Professional Land Surveyor
McClintock Land Associates, Inc.

1-14-2015

Date

All files are dated 1/08/2015

L31025_15900-Surface.dwg	L31275_15550-Surface.dwg
L31025_15925-Surface.dwg	L31275_15575-Surface.dwg
L31050_15850-Surface.dwg	L31275_15600-Surface.dwg
L31050_15875-Surface.dwg	L31275_15625-Surface.dwg
L31050_15900-Surface.dwg	L31300_15475-Surface.dwg
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L31200_15675-Surface.dwg	L31475_15300-Surface.dwg
L31200_15700-Surface.dwg	L31475_15325-Surface.dwg
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L31275_15500-Surface.dwg	L31525_15175-Surface.dwg
L31275_15525-Surface.dwg	L31525_15200-Surface.dwg

QA/QC Report

Tetra Tech has performed quality control throughout each step of the acquisition and processing for the Bradfield to Behms corridor project area. The only difficulty encountered was during the acquisition phase of the project, waiting for suitable weather conditions for collection. Difficult weather conditions were a challenge and caused delays and offsets between LiDAR acquisition, image acquisition and ground survey. Our flight teams remained on-site and acquired LiDAR at a lower altitude that enabled collection below cloud deck. The data was immediately checked for quality to determine if the lower flight altitude would affect the data. There was no adverse effect on the data.

Processing Report

Imagery

The imagery was acquired with an UltraCam Eagle digital frame camera on November 1 and 11, 2013. The camera was equipped with airborne GPS and inertial unit (IMU). The image acquisition was planned in conjunction with survey of ground control points and collection of airborne LiDAR data. An aerotriangulation was performed in the Inpho / Trimble Match-AT version 5.7 software. For orthorectification a digital elevation model with 3ft grid spacing was generated from the LiDAR data. The Orthoimagery was then created in Inpho / Trimble OrthoMaster version 6.0 and mosaicked and color balanced in OrthoVista 6.0. MrSID compressed files were created in Lizardtech Geoexpress 9.

For additional information on the image processing see the AT log file and the camera calibration report and GPS shapefile in the imagery directory. Information regarding the processing is also contained in the xml metadata file accompanying each image (i.e. each individual geotiff tile, the complete MrSID mosaics and the individual unbalanced orthoimages).

Aerotriangulation

The AT relies much on the airborne GPS and IMU. In addition we used ground control points 501, 502 and 506 as vertical control. A datum shift of the airborne GPS was applied.

Orthorectification

The imagery was orthorectified in OrthoMaster using a 3ft spacing DEM generated from the LiDAR data, classes 8 and 9.

4 band unbalanced "raw" orthoimages: the raw aerial images were converted from 16 bit to 8 bit, 4-band imagery without balancing. The imagery was then orthorectified to the full extent of each image. During the orthorectification process images were clipped to the area of interest (AOI) since no DEM is available outside that area.

3 band True Color RGB and Color Infrared CIR mosaics: 8 bit balanced 4 band images were orthorectified. During the orthorectification process images were clipped to the AOI. Seamlines were generated automatically. Images were radiometrically balanced in OrthoVista and then written out into two sets, 3 band RGB and 3 band CIR geotiff tiles. These tiles were combined to a MrSID mosaic in Lizardtech Geoexpress 9. See Figure 1 for organization of the image data delivery.

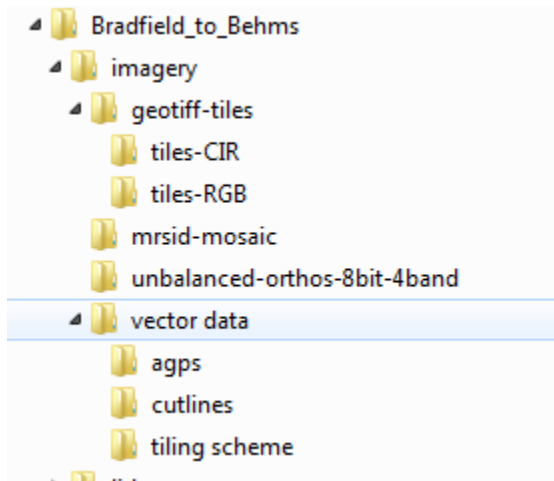


Figure 1: Organization of image data

The LiDAR data for the Bradfield to Behms corridor was acquired on June 26 and 27 and July 11 of 2014. SBET and shapefile of the trajectory are located with the point cloud data (see Figure 2 for the organization of LiDAR and LiDAR derived data). The data was post processed through PosPac, Waypoint's GPS and IMU (inertial measurement unit) post processing software, and LMS, Optech's LiDAR post processing software. PosPac is used to generate the trajectory file which contains the position (X, Y, Z) from differential GPS observations and the plane's attitude (roll, pitch, heading) from the IMU. LMS is used to join the discrete point range information to the trajectory information through a common time stamp and to calibrate the data. The calibration is achieved by first identifying common features in the overlap of adjacent flight lines, and then adjustments are applied to the IMU's angular offsets to align the data. Once finished, LMS refines the calibration further through a bundle adjustment to create the final calibrated data set.

Classification of the calibrated LiDAR data set is achieved through the use of TerraScan, the industry standard software from TerraSolid for classifying LiDAR. Individual macros were defined that derive and refine a ground surface, vegetation, and buildings. These macros are also used to eliminate spurious points below the surface and high point artifacts. The Bradfield to Behms area was then manually checked and edited to eliminate low and high points as well as to ensure that points are classified appropriately.

Breaklines were derived from LiDAR and imagery and help define water classes in the LiDAR data.

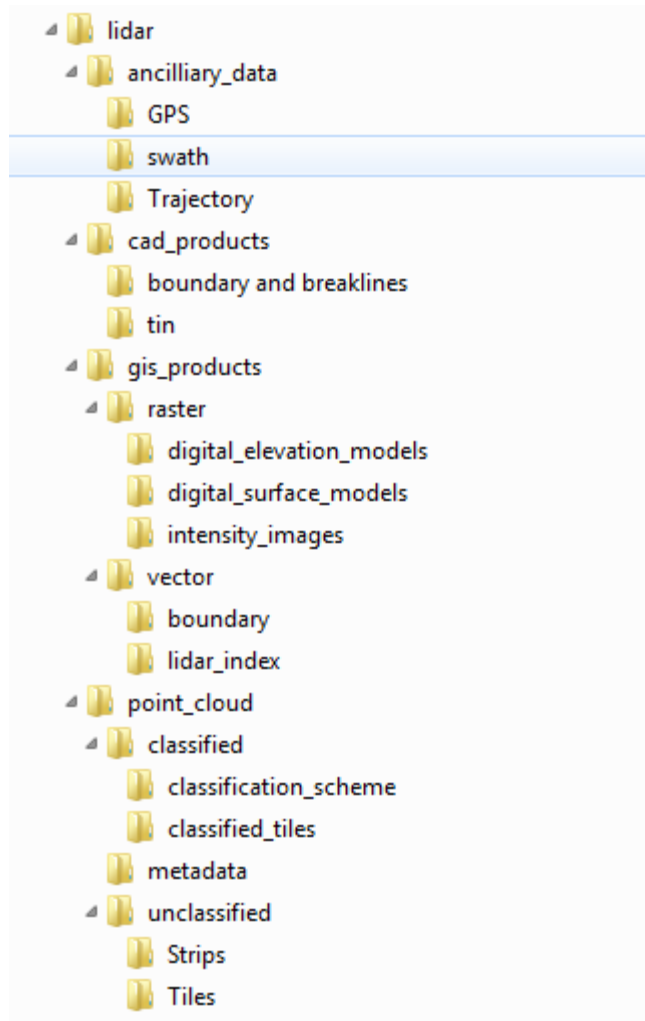


Figure 2: Organization of LiDAR data

DSM

The DSM was created from LiDAR first returns and only-returns. A thinning within 1' cells was applied to select points that contribute to the DSM. This selection occurred in Terrascan. Points were then imported into a geodatabase. A terrain was created in 3D Analyst from the imported points and subsequently a 3' spacing grid was generated, using the NATURAL_NEIGHBORS interpolation method.

The ERDAS imagine mosaic tool was then used to clip and tile the DSM at the same time into individual geotiff tiles.

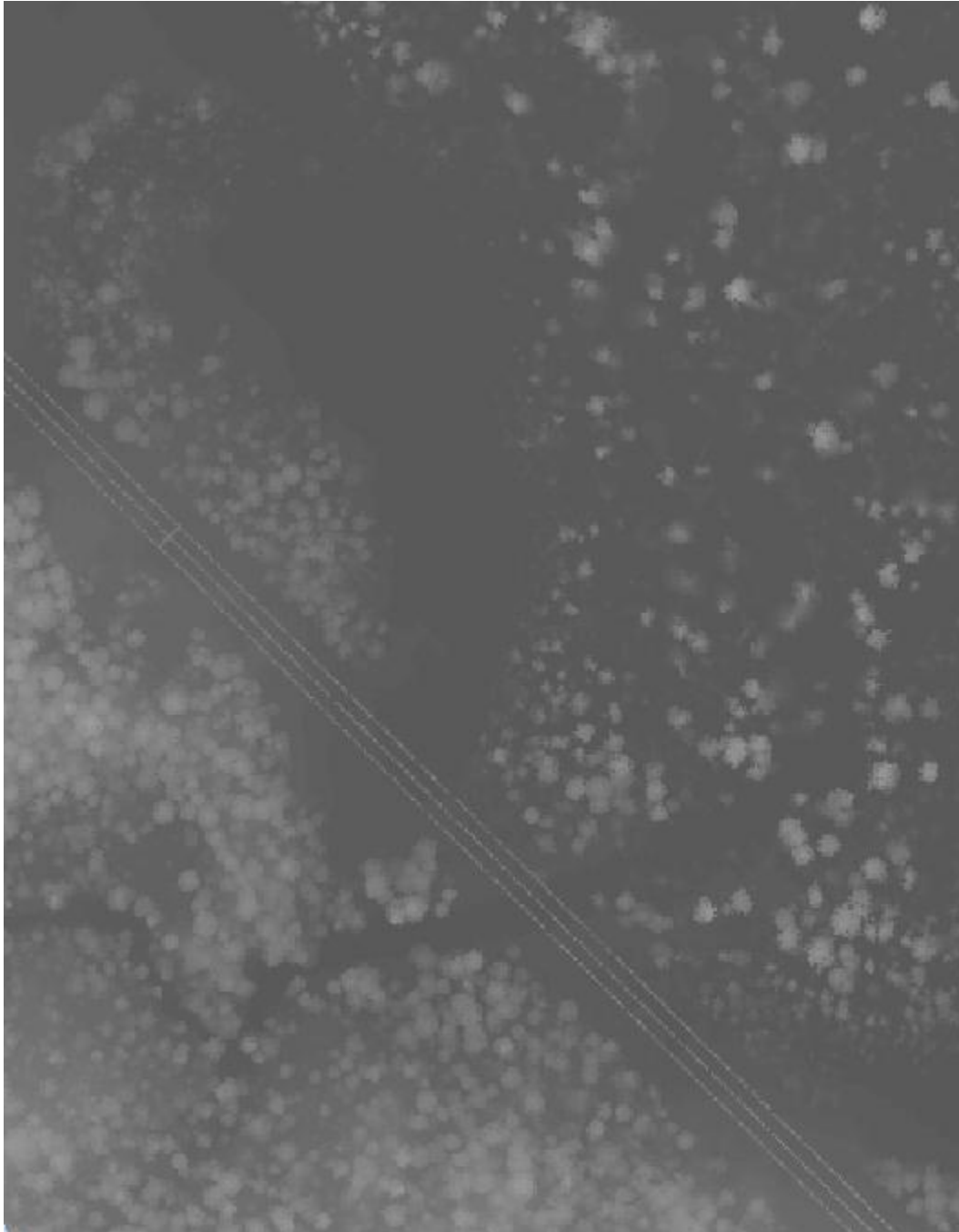


Figure 3: Result, DSM with 3ft grid spacing.

DEM

The DEM was created using ESRI 3DAnalyst. The individual steps included:

- Importing all las files into the geodatabase as multipoint, all returns, classes 8 and 9.

- Importing the breaklines as a feature layer.
- Creating a terrain in 3D Analyst from all mass-points and breaklines.
- Creating a 3' spacing grid, using the NATURAL_NEIGHBORS interpolation method
- The ERDAS Imagine mosaic tool was then used to clip and tile the DEM at the same time into individual geotiff tiles (Figure 4).

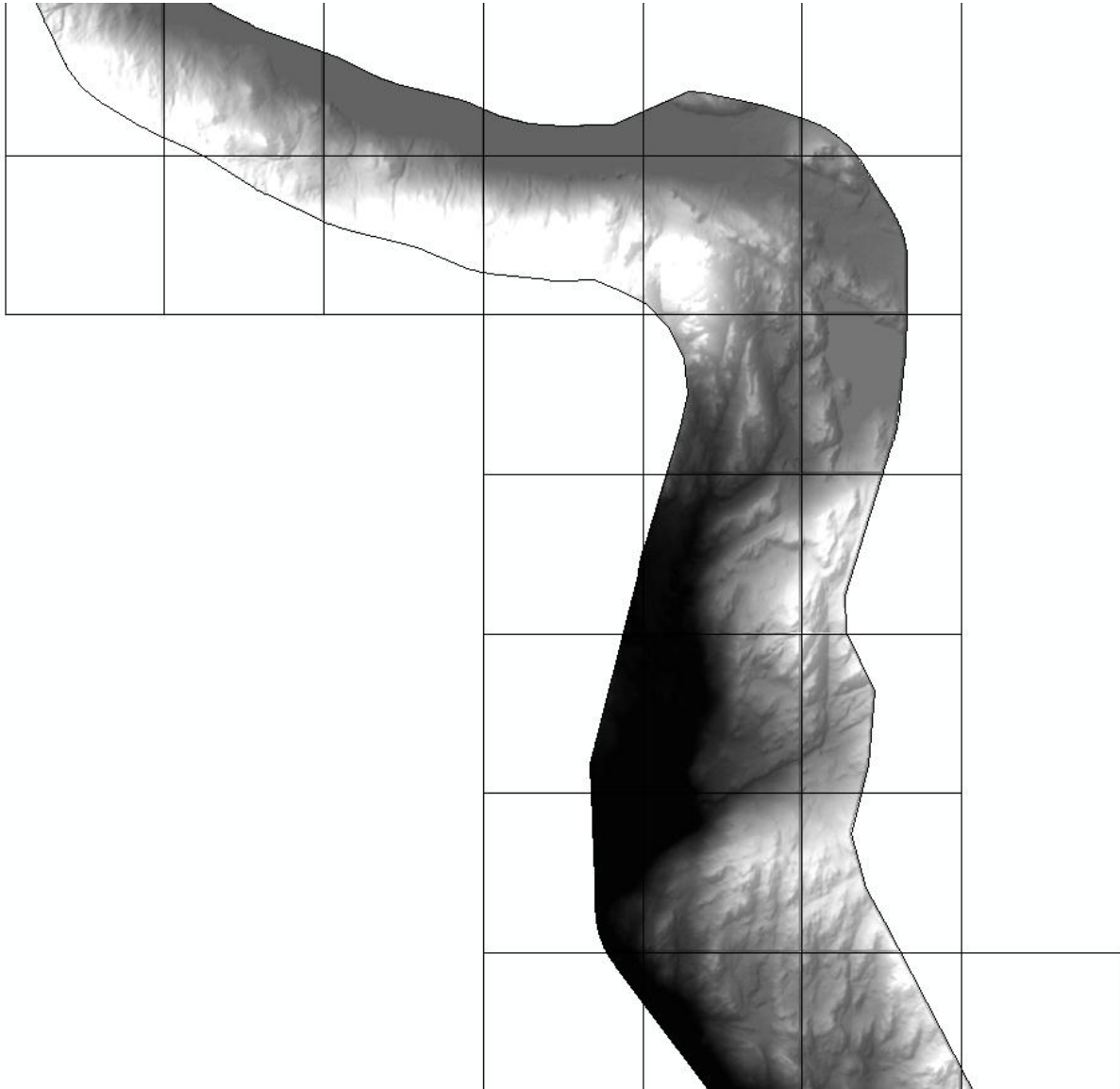


Figure 4: DEM as a shaded relief overlaid with the tiling scheme.

Intensity Image

- The intensities were exported from the LAS files in the LP360 software to one ESRI grid with 3ft. spacing.
- The grid was then exported in ESRI to a geotiff with data type float.
- The geotiff was again clipped to the AOI and tiled to the LiDAR tiling scheme in ERDAS Imagine.

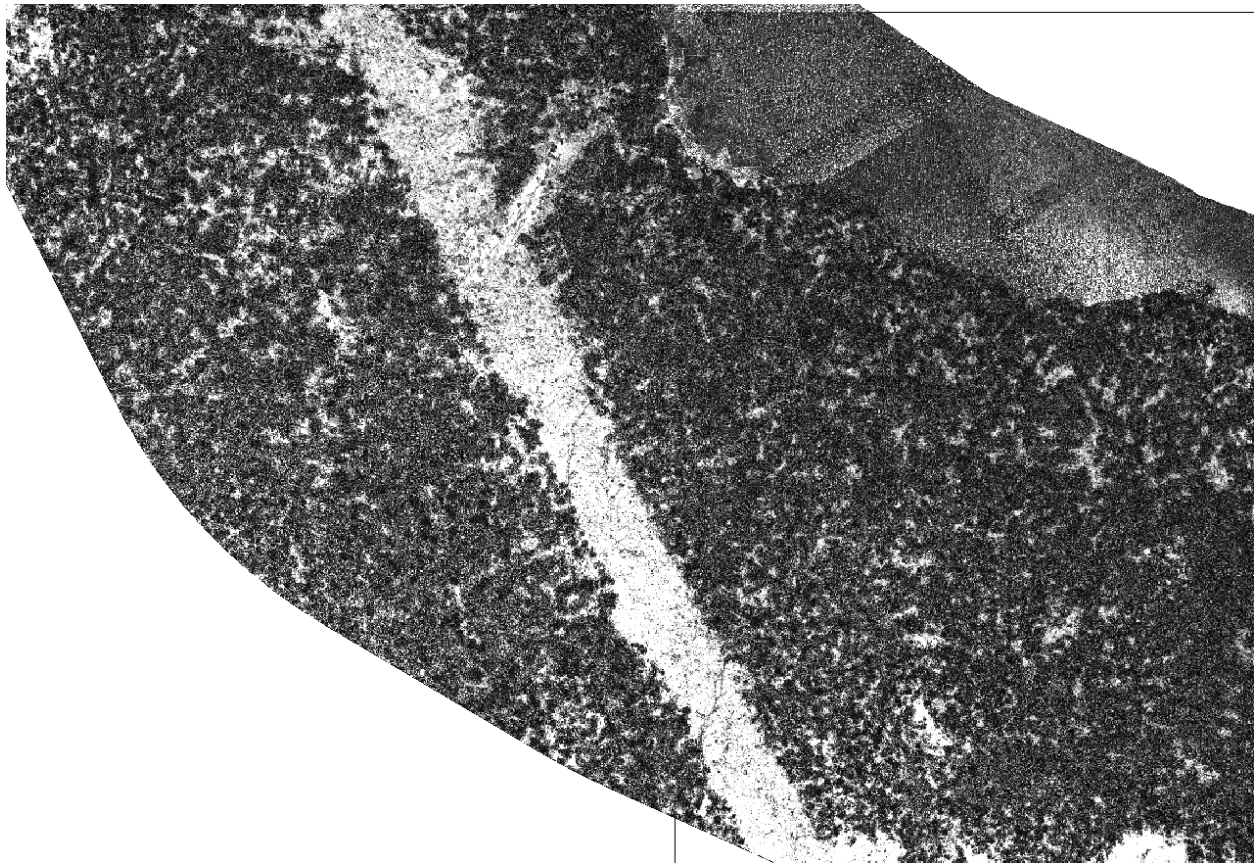


Figure 5: Intensity image, 3ft spacing, float values.

TIN

TIN creation based model key points

In producing a TIN from LiDAR data, it is common practice to use model key points and breaklines. Model key points are thinned from the LiDAR ground points to represent the terrain, and allow for an accurate but less dense data set. Model key points are exported from the las files into csv format, with



150 ft. over edge beyond the tile boundary. Breaklines are imported directly into the Civil3D file, while the csv is referenced externally to create the TIN.